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THE IR&D PROGRAM OF THE DEPARTMENT OF DEFENSE

by Judith V. Reppy

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Judith V. Reppy

Research Associate
Peace Studies Program
Cornell University

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ACRONYMS

ASPR	Armed Services Procurement Regulations
B&P	Bid and Proposal
DCAA	Defense Contract Audit Agency
DCAS	Defense Contract Administration Service
DDRE	Defense Director Research and Engineering
DOD	Department of Defense
GAO	General Accounting Office
I&L	Installations and Logistics
IR&D	Independent Research and Development
NSF	National Science Foundation
PMR	Potential Military Relevance
R&D	Research and Development
RDT&E	Research, Development, Test and Evaluation

The IR&D Program of the Department of Defense

I. INTRODUCTION

Independent Research and Development and Bid and Proposal (IR&D/B&P) are two important but little known programs by which the Defense Department supports in-house research and development done by the nation's defense contractors. In contrast to the R&D which these firms perform on contract for DOD or for other customers, IR&D is company-initiated; it differs, however, from the in-house R&D of nondefense industries in the way in which it is paid for. Under DOD regulations IR&D costs are allowable costs which can be charged as overhead on defense contracts. Since the prices of most defense contracts are negotiated on the basis of the contractor's costs, the defense company, unlike a company selling in ordinary markets, is certain of covering a large fraction of the cost of its IR&D program.

Bid and Proposal costs are the costs incurred in preparing bids for contracts or in submitting unsolicited proposals to the government; these costs too can be charged against government contracts. B&P includes both the administrative costs of proposal preparation and the costs of developing supporting technical data to respond to government specifications. In practice the latter costs are indistinguishable from those for IR&D, and for most purposes IR&D and B&P can be considered together. The Defense Department has recognized this overlap by setting up similar rules for the two categories

in its procurement regulations. In this paper we shall refer mainly to IR&D, with the understanding that the discussion is applicable to a large part of the B&P program also.

In 1974 the major defense contractors recovered $808 million from the Defense Department for IR&D/B&P costs, and an additional amount, estimated at about $200 million, was paid to smaller contractors.[1] But this money did not appear in the DOD budget under the heading "Research, Development, Test and Evaluation" (RDT&E), nor were any specific results of the program listed in the Director of Defense Research and Engineering's (DDRE's) annual report to Congress.[2] Because DOD's share of IR&D/B&P costs is paid through overhead charges on defense contracts, the program is not identified in the budget. Most of the money for IR&D comes from the procurement section of the budget, with the RDT&E budget contributing only the proportion which is charged via overhead to R&D contracts. This anomalous situation is an important factor in explaining the relative obscurity of the IR&D program. Each year Congressional committees hold extensive hearings on the RDT&E budget of the Pentagon, yet the IR&D program was virtually unknown to the Congress until Senator Proxmire first focused attention on it in 1969. At that time Senator McIntyre, Chairman of the Subcommittee on Research and Development of the Senate Armed Services Committee, admitted on the floor of the Senate that he had never before heard of IR&D.[3]

The following year Congress held hearings on IR&D and passed legislation mandating certain procedures for DOD's

management of the IR&D/B&P program. The Commission on Government Procurement took up the question, and the General Accounting Office (GAO) has made a series of studies on the implementation of the 1970 law. Most recently, in September 1975, the Subcommittee on Research and Development, Senate Armed Services Committee, and the Subcommittee on Priorities and Economy in Government, Joint Economic Committee, held three days of hearings on the IR&D program.[4]

Throughout the hearings the defense contractors have strongly supported IR&D as a normal business practice, one whose costs should be recovered from the Defense Department as from any other customer. They argue that their IR&D programs provide incentives for innovative work and a flexibility which are lacking in contract R&D. The Pentagon also supports the program, extolling it as a way of encouraging new ideas, increasing competition in the defense industry, and maintaining a healthy technology base at a relatively low cost to the government. Critics, however, claim that the IR&D program is unnecessary, given the billions spent for contract R&D each year by the Defense Department. They argue that there is no evidence that the benefits of the program have been commensurate with its costs; indeed, it is described as a virtual subsidy to the defense industry. Some companies, it is charged, have used IR&D funds to gain a technological advantage in their nondefense undertakings, or to cover cost overruns on defense contracts. But the chief criticism has been leveled at the fact that the program has been funded

outside the regular RDT&E budget of the Defense Department withough Congressional oversight.

Although the dollar amounts reimbursed by the Defense Department for IR&D programs appear small relative to a $100 billion defense budget, they are substantial compared to other categories of government spending. For example, funds for IR&D/B&P have exceeded the total National Science Foundation budget for every year for which data are available. Within the defense budget, IR&D/B&P funds equal about 10 percent of the RDT&E budget, and about 40 percent of the funds allocated by DOD to its own in-house laboratories. DOD payments for IR&D (not including B&P) are almost equal to the amounts spent in industry via RDT&E contracts for support of the defense technology base. Viewing these figures as an expression of a national science policy, we can ask whether this distribution of resources between different R&D programs is an optimal one.

The support of defense research and development work outside the RDT&E budget raises the question of accountability to Congress. At present, the size of the IR&D program is not subject to external budget review, but instead is the result of internal DOD decisions and negotiations with its major contractors. The only mechanisms for Congressional oversight in the program are the opportunity to ask questions during Congressional hearings on the defense budget and a requirement for an annual report on IR&D/B&P. The annual reports, however, are not very informative. They list the IR&D/B&P

costs of the major defense contractors as a group and DOD's share of those costs, but there are no details on which companies receive the money and what they do with it. Nor does the annual report attempt to demonstrate the ways in which the program is responding to the formal goals set for it by DOD. The lack of this type of information effectively precludes the Congress from forming a valid judgment on the value of the IR&D program.

In addition to the question of Congressional oversight there is also the question of the Pentagon's management of the IR&D program. Over the years, the Defense Department has developed management procedures which are described as providing adequate control over the size and quality of IR&D programs in the individual firms without interfering in the ability of the firms to make independent decisions on the direction of their programs. These procedures include technical evaluation by DOD scientists of the IR&D programs of the major defense contractors, and the negotiation of ceilings on the dollar amounts which DOD will pay. The effectiveness of these measures, however, may be doubted. In practice DOD's evaluation of the technical quality of a company's proposed IR&D program has only a limited effect on the negotiations for its program ceiling, although such a link would seem to be a prerequisite of good management. Furthermore, there is still disagreement over some of the principles embodied in DOD's rules on IR&D. Should the Defense Department support only R&D which is relevant to the defense

function or should it accept a broader definition of relevance? Should projects which are aimed at commercial markets be allowed? Are on-site reviews of IR&D programs indispensable to evaluation procedures or are they an expensive luxury which can be replaced by review of technical write-ups? How serious are the problems posed by what is politely called "creative accounting," i.e., the problem of companies classifying their costs in ways designed to enhance their cost recovery from the government. These questions are important because an evaluation of the IR&D program must consider not only the stated goals for the program but also whether or not it functions to fulfill those goals.

A final category of issues are those which may be grouped together as indirect effects of the IR&D program. The disbursement of large amounts of money, for certain activities only, and to certain firms only, inevitably has had effects on the internal structure of the firms, on the overall structure of the industry, and conceivably, on the defense posture of the United States. IR&D projects represent an entry point into the weapons pipeline; indeed, hope of winning future contracts is the major incentive for firms doing IR&D. If, as some have argued, U.S. weapons decisions are often the result of a technological imperative rather than stemming from a rational analysis of military requirements, then IR&D represents an early step in the development of technological pressures. It is possible that the cumulative impact of these indirect effects in the areas of industry

structure and strategic decisions are more important to our ultimate judgment of IR&D than the evaluation of the stated aims of the program, more narrowly defined. Before these policy issues can be adequately dealt with, however, we must describe more fully the historical growth of the program, the current industry environment, and the character of DOD controls.

II. BACKGROUND

History of the Program

The evolution of the present IR&D program can be traced to the period during and following World War II. The government's wartime reliance on private industry for its military procurement needs continued into the post-war period. It led to the apparently permanent arrangement we now have in which private contractors supply not only military products, but also most of the R&D for new weapons. As the contractual arrangements between government and the defense industry have grown in number and complexity, the Armed Services Procurement Regulations (ASPR) which set forth the rules governing these contracts have undergone constant expansion and change. The rules for cost recovery of expenditures for IR&D/B&P are no exception.

The first edition of ASPR in 1949 allowed contractors to charge contract-related development costs and bid and proposal expense to their DOD contracts, but did not allow independent research costs unless specific authorization was

included in the contract. Contracts with the large defense contractors often carried such authorization, but the practice was not uniform. The revised cost principles issued in 1959 marked the beginning of the current practices. Costs for independent research were to be routinely allowed, subject to tests for reasonableness and allocability. "Reasonableness" is, in practice, defined by the negotiator for DOD; allocability refers to the pro-rating of a contractor's costs across all of his customers in proportion to their share of his total business.

With the new rules for accepting IR&D costs, DOD began to impose controls on the sums it was paying out. Large companies were asked to negotiate advance agreements which set dollar ceilings on their IR&D programs. In an effort to provide incentives for efficient use of the funds, cost-sharing between the government and the contractor was required for IR&D costs, although not for B&P expense. Predictably, this led companies to classify as much as possible of their development costs under the heading B&P. This, in turn, led to chronic disagreement between the Defense Department and its contractors over the proper classification of costs, and to a lack of uniformity of treatment between services and between different contracting officers.

During the 1960's significant changes were also being made in DOD's overall procurement policies in an attempt to deal with the cost growth which had been common in the 1950's. Among the new management controls introduced under Secretary

of Defense McNamara was an increased use of fixed price incentive contracts to replace cost-plus contracts. From 1951 to 1960 the proportion of cost-plus contracts had grown from 13 percent to 43 percent, but under McNamara it declined, reaching a low of 21 percent in 1966-67.[5] A procedure called "total package procurement" (TPP) was introduced, designed to shift to the contractor the responsibility for cost overruns. Under TPP the contractor was asked to commit himself to a price for production at the time the contract for development work was awarded, in an effort to eliminate the practice of "buying in" with a low initial bid and "getting well" later.

The effect of these changes was to increase the contractor's vulnerability to cost overruns caused by unanticipated technical problems. Under fixed-price type contracts the increased contractor risk could be offset to some extent by inflating the target costs in the contract in order to reduce the likelihood of overruns.[6] Another response was the use of IR&D programs to solve technical problems, with cost recovery via IR&D/B&P or another, related, cost category, "Other Technical Effort" (OTE).[7] These indirect cost categories were used to cover the costs of technical preparation for contracts, costs which had previously been absorbed rather easily under cost-plus contracts.[8] The result was a substantial growth in IR&D/B&P costs during the 1960's.

The McNamara reforms proved unsuccessful in controlling the costs of defense procurement, as notably illustrated by the case of the C5-A aircraft. They were dropped in the early

1970's in favor of a return to separate contracts for development and production, the use of cost-plus contracts for the development stage, and an emphasis on using competitive prototypes as the basis for procurement decisions. IR&D/B&P costs have not fallen off, however, except for a brief drop in 1970-71. Instead, there have been substantial forces at work, described in later sections of this paper, which have tended to maintain the size of the program.

Table 1 shows DOD reimbursement to major contractors for these cost categories, both in dollars and as a percent of their sales to DOD, from 1963-1974. These figures are estimated to cover 80 to 85 percent of DOD's total IR&D program; they do not include the DOD's share of IR&D/B&P costs for smaller contractors.[9] Allowing for unreported costs, DOD's payments for IR&D/B&P for 1974 were in the neighborhood of one billion dollars. Although there are difficulties with these data because of frequent shifts in definitions and coverage, the steady upward trend during the 1960's is unmistakable.[10] Data from NASA are also included, since its IR&D program is modeled on DOD's and covers many of the same major contractors as DOD's. The absolute size of NASA's IR&D/B&P program has shrunk with the cutbacks in spending for space programs, and, unlike DOD, program payments as a percent of sales to NASA have declined since 1971.

The upward trend in DOD's spending for IR&D was interrupted in FY 1970 by two developments. One was the drop in procurement spending with the wind-down of U.S. involvement

in the Vietnam War. Since DOD's share of IR&D/B&P costs is paid as an overhead charge on defense contracts, it tends to drop with a drop in military procurement. The second factor was that in 1969, for the first time, Congress became aware of the IR&D program, and an attempt to limit it was written into the FY 1970 Military Procurement Authorization Bill (PL 91-121). The language adopted can only be described as ridiculous (spending was limited to 93 percent of what it "would have otherwise been," a completely unspecified base figure), but the spectre of Congressional interest apparently had an inhibiting effect on the growth of IR&D spending.

The opening skirmish in 1969 was followed by Congressional hearings in both the House and Senate during 1970, and new language on IR&D was included in the Military Procurement Authorization Act for FY 1971 (PL 91-441, Sec. 203). The law now requires that all companies receiving more than $2 million annually in IR&D/B&P costs from the Defense Department must have an advance agreement, establishing a firm dollar ceiling on DOD's contribution to these costs. The law further requires that the IR&D programs be evaluated for technical quality and for relevance to the functions of the DOD. Projects which do not have "potential military relevance" (PMR) cannot be included in the portion of total costs reimbursed by DOD. Each year, the Secretary of Defense must submit an annual report on the IR&D/B&P program, including the total dollar amount paid to major defense contractors but not including data for individual companies. These reports are

published in the Congressional Record; in addition to dollar amounts for the program they include a description of any changes in DOD's management procedures for the IR&D/B&P programs. They do not, however, provide any information on the projects undertaken or on their results. As a result of the 1970 legislation, the IR&D program has greater visibility than it did before, but there is still no effective Congressional oversight prior to the commitment of funds nor any evaluation by Congress of program results. The Defense Department, itself, maintains only loose administrative controls on the program, arguing that it gains innovative capability in exchange for strict accountability.

Recently, another factor has entered the debate over public policy for IR&D. Following the Report of the Commission on Government Procurement in 1972, an interagency task force was established to formulate a proposal for a uniform IR&D policy covering all government agencies. The Commission divided sharply on the IR&D question; the task force chose to propose retaining the current DOD policy, revised only to require government-wide relevance instead of potential military relevance for IR&D projects. This recommendation, if accepted by the Office of Federal Procurement Policy, will require congressional action before being implemented, since the relevancy proposal involves changes to the 1970 legislation (PL 91-441).[11]

IR&D in Relation to Other DOD Programs for R&D

The IR&D program must be viewed in the perspective of the total program for military R&D. The Defense Department currently spends about $10 billion per year on its budgeted RDT&E. The DOD's payments to major companies alone for IR&D/B&P equal nearly 10 percent of this amount, a fraction which increased steadily during the 1960's as the IR&D program grew (see Table 2). The payments are a much more substantial fraction of that portion of the budgeted R&D which goes to support the technology base. Funds in two categories of RDT&E, Basic and Applied Research (6.1) and Exploratory Development (6.2) are usually taken as being equivalent to spending on the technology base (although DOD has recently begun to include some projects from the 6.3 category, Advanced Development, also). In FY 1974 DOD payments for IR&D alone, not including B&P, were equal to about 30 percent of the total budgeted for the 6.1-6.2 categories. More significantly, they were almost equal to the amounts spent in industry through RDT&E contracts for the technology base (Table 3). Thus the IR&D program is potentially an important addition to the resources available for developing the technology base, especially in the private industrial sector.

IR&D's relation to the RDT&E budget can be viewed in another light. The funds expended are used for programs which are part of the R&D function. But the actual costs are reimbursed through overhead charges allocated to all of

a contractor's business. This means that the RDT&E budget is charged for only about 30 percent of the DOD's payments for IR&D costs, with the rest coming out of the procurement budget.[12] Although reaching 10 percent of the RDT&E budget, the IR&D/B&P program is equal to an overhead charge of only 3.5 to 4.0 percent on the IR&D companies' total sales to the Defense Department. From this point of view, IR&D represents a bargain for the R&D program of the Defense Department, while still not looming large in the procurement category.

III. IR&D AND THE DEFENSE DEPARTMENT

The Defense Department's Objectives for the IR&D Program

The Defense Department has consistently supported the IR&D program as an important element in its total R&D program and in its relationships with military contractors. Formally, three objectives are listed for the IR&D program.[13] First, IR&D is seen as a means of strengthening the technology base of the industry. The absence of tight DOD controls, it is argued, creates an environment conducive to real innovation. The IR&D program provides incentives to the defense firms to allocate resources to R&D in military-related areas and to explore a diversity of approaches to technical problems in addition to those chosen for funding through contract R&D. The Defense Department claims also that the IR&D program reduces the total costs of weapons procurement by allowing DOD to purchase already developed components "off the shelf."

A second, related objective given for the IR&D program

is to increase competition in the defense market by developing technical competence in more than one supplier for any specific requirement which the DOD may have. By this use of the word "competition" the Defense Department obviously does not intend the specialized meaning of the economist, who refers to a market characterized by many buyers and sellers, a homogenous product, and free entry. The defense market deviates sharply from this ideal type, but, by supporting more than one contractor in a technical area, the DOD hopes to gain some of the benefits of competition. In addition to the gains in innovation resulting from increased technological rivalry, an effect which properly belongs under the first objective, the presence of alternative sources of supply reduces the market power of individual contractors and protects the DOD from the risks of relying on a single firm. It may also result in lower prices, although, for a variety of reasons, price competition is not strong in the defense market.

The third objective listed by the DOD for the IR&D program views it as contributing "as appropriate" to the economic stability of the defense industry by encouraging diversification within the individual firm. Such diversification reduces the firm's vulnerability to shifts in procurement policy, and, it is hoped, enhances the long-run health of the industry.

It should be noted that the objectives stated by DOD for the IR&D program are not wholly consistent. Encouraging firms to diversify may in fact lead to resources being pulled

from the defense market. Maintaining alternative suppliers in specialized technical areas does not necessarily yield lower prices for defense procurement; the market may be shared according to some non-competitive principle.[14] Furthermore, the IR&D program is poorly designed to increase the numbers of alternative suppliers. Because IR&D costs are recovered through an overhead charge, the largest sums of money go to the largest, well-established defense contractors and to those technical areas for which there are already many contracts. Electronics is an obvious example: of the top 100 DOD prime contractors in fiscal year 1974, nineteen were in the electronics industry,and other major contractors, particularly in the aircraft industry, also performed military-related electronics work. Meanwhile, less-populated technical areas where the DOD might wish to increase the number of suppliers receive a relatively small portion of the total IR&D funds. And firms outside the defense market do not receive any of the program funds, even though entry by such firms would provide both new technical initiatives and a larger measure of competition.

There are other DOD programs which serve the same objectives as those held for the IR&D program and do so within a framework of contractor accountability. The willingness of the Defense Department to spend close to a billion dollars a year on IR&D/B&P without such accountability is thus somewhat puzzling; it seems to flow from a mixture of a

genuine belief in the program's contributions to innovation in defense technology and a willingness to accommodate its contractors.

DOD's Management Structure for the IR&D Program

Following the Congressional action of 1970, the ASPR were amended to incorporate the legislation's requirements for advance agreements, technical evaluation and potential military relevance for IR&D. Advance agreements and technical evaluations of its largest contractors were already features of DOD's management of the IR&D programs but a new formal structure was now created to oversee DOD policy. Heading the new structure is the IR&D Policy Council, made up of the Defense Director for Research and Engineering (DDR&E), the Assistant Secretaries of Defense for Comptroller and for Installations and Logistics (I&L), and the Assistant Secretaries for R&D and for I&L from each of the services. The Policy Council is responsible for the DOD's overall policy on IR&D, including determination of the level of support for the program and the criteria for potential military relevance. Reporting to the Policy Council is the Technical Evaluation Group which establishes the procedures for the technical evaluation of the IR&D programs of the major defense companies. There is also an informally organized group in the Office of the Secretary of Defense (I&L) which serves as liaison between the contract negotiators in the three services.

Implementation of DOD policy for IR&D rests on (a) the scientists at the military laboratories who do the technical evaluations, (b) the service negotiators who carry out the negotiations of advance agreements with the major companies, and (c) the staff of the Defense Contract Administration Service (DCAS) and the Defense Contract Audit Agency (DCAA), who administer and audit the IR&D clauses of a contract. The latter organizations are not usually important elements in the management of IR&D; the program is just too small relative to their other concerns to gain much attention from the auditors.

How the Program Operates

Each defense contractor with an IR&D program goes through an annual cycle of internal decision-making and interaction with the Department of Defense in planning and performing its IR&D. The most important stages in this process are described below, first for a major company with an advance agreement and then for a company without an advance agreement.[15]

1. Program planning by the company

The defense firm realistically see its IR&D program as an important element in its pursuit of new contracts. Through IR&D projects the firm can develop its technical capability to bid for and obtain future contracts and can communicate its successful developments to the Defense Department, with the hope that they will reappear as future procurement requests. Informal contacts with the DOD are important, since

a firm which learns of a procurement action only through a formal "request for proposal" will be months behind its better informed rivals in preparing to bid. The contacts are made through organized seminars, visits to project offices in DOD, the review process for IR&D technical plans, and on-site visits. In addition, companies will scan DOD's formal planning documents and the specialized journals such as Aviation Week and Space Technology for clues as to which technical areas are most likely to be funded. These efforts form the background for the company's selection of its own IR&D projects.

By the beginning of its fiscal year, each major contractor for DOD (or NASA) puts together a technical plan or "brochure" for its IR&D program for the coming year, selecting from the projects proposed by its staff those which appear most likely to lead to future contracts. The technical plan of a large company will run to several hundred pages and may contain descriptions and projected costs for literally hundreds of projects, ranging from short-term exploratory efforts to large-scale development projects.

Strategies in selecting IR&D portfolios vary considerably between firms, a fact which showed up even within the small sample of companies interviewed for this study. A firm may choose to concentrate its resources in a few, large projects on the grounds that this strategy leads to better ratings during the technical evaluation procedure. Large well-funded projects appear important to the evaluator, and

there is a greater probability that something will be accomplished with a substantial investment in dollars and manpower. Other firms undertake many separate projects each year, most of them relatively small in scope. The emphasis here is on short-term exploratory efforts, making the most of the flexibility which IR&D offers over contract R&D.

2. Technical evaluation of the proposed program by the DOD

The company sends its technical plan to the designated manager of its "lead" service, that is, the military department which has been assigned responsibility for handling IR&D matters for this particular company on behalf of DOD as a whole. The manager circulates the individual project descriptions to the appropriate service laboratories (including laboratories of other services) for expert evaluation. Each project is given a score by the service evaluator and is checked for potential military relevance. The technical ratings for all the company's projects are then weighted by dollar cost and consolidated into a single numerical score on a scale of 1 to 10. This rating is forwarded to the service's negotiating team. Some months after the technical evaluation is complete the company will receive a report on the results, but this debriefing usually occurs near the end of the year, so that it is of use mainly in planning the next year's program.

In addition to evaluation of the written brochures, once every three years the DOD holds an on-site review of

each major company's IR&D program. The purpose of the on-site review is to allow the DOD scientists to get a close look at what industry is doing and to ascertain if the company's written brochure properly represents its IR&D program. The on-site review is not a complete check on the regular evaluation procedures, however. Owing to limitations on cost and time, only about 30 percent of a company's projects are covered in an on-site visit, and they are selected in consultation with the company to be of interest to the DOD personnel who will take part in the on-site review. Naturally, the sample of projects contains the company's best efforts, which tend to be viewed sympathetically by scientists with matching interests. Technical ratings from on-site reviews run systematically higher than ratings based on evaluation of written brochures.[16]

Conspicuously lacking in the evaluation procedure is any comprehensive review of completed projects. Work in progress is evaluated partially on the basis of the portions already completed, but the greatest weight in the scoring is given to the work proposed for the future. There is no point in the evaluation procedure at which the results of a completed project are weighed against its total cost and compared to other projects in a systematic way. The DOD and the industry argue that such a review would be inappropriate, since IR&D projects are not "purchased" by the DOD under contract; however, the absence of any after-the-fact evaluation on a regular basis prevents the government from clearly

identifying the benefits and costs of the IR&D program.

3. Negotiation of an advance agreement

The company's advance agreement for its proposed IR&D program is negotiated between the company and its lead service; representatives of other services and NASA are invited to participate, but, whether they do so or not, they are bound by the final results. Because of the time lags inherent in the technical evaluation procedures, in most cases the technical rating available to the service negotiators is the score earned by the company's technical plan in the previous year. The main factors affecting the negotiations are the historical size of the company's IR&D program, its expected sales to the DOD in the coming year, and the historical share of its cost borne by the DOD. The score from the technical evaluation and the degree of military relevance also enter into the negotiation, but to a lesser degree.[17] This emphasis in the negotiation on historical factors creates a stable situation in which program size is fairly predictable, both for DOD and for the individual company.

The advance agreement places a ceiling on the size of the IR&D program which the DOD (and NASA) will accept for allocation. That is, the DOD agrees to pay its allocable share, based on its share of the company's total sales, up to the negotiated ceiling; the company must cover all the costs incurred over the ceiling. A projected overhead rate for IR&D, expressed as a percent of sales, is computed from the company's negotiated ceiling and its expected volume of

sales to the DOD. This rate is used in pricing all of the company's contracts with DOD (and NASA) for the year the agreement is in effect, thus relieving both the government and the company from the necessity of negotiating an IR&D overhead rate separately for each contract.

An example may be helpful. Consider a defense contractor with an expected annual sales to DOD of $500 million, an amount representing 75 percent of its total sales. The company negotiates an advance agreement with DOD for a ceiling of $16 million on the IR&D costs which DOD will accept for allocation. The $16 million ceiling represents the allowable costs on which the DOD will pay its allocable share of 75 percent, or $12 million. The overhead charge for IR&D on contracts and subcontracts for DOD (totalling $500 million) would be set at 2.4 percent. A similar exercise is needed to arrive at a recovery rate for B&P costs. Note that the company must spend $16 million on IR&D to recover $12 million from DOD. If it spends less, it will receive proportionately less, but if it spends more than the ceiling it must cover the excess costs itself. If the actual sales of the company to DOD vary from the $500 million figure, the recovery rates for IR&D and B&P are adjusted as part of the regular post audit procedures.

In recent years the major companies, taken together, have spent more than their negotiated ceilings for IR&D/B&P by approximately 15 to 20 percent. The fraction of costs allocated to the Defense Department has ranged from 60 to 67

percent of the negotiated ceilings, or about 50 to 57 percent of the total costs incurred by the companies. The companies are recovering a further 5 percent or so of their total IR&D costs from NASA; this figure is down from a high of 17 percent or more in the 1960's. The proportion of total B&P costs recovered from DOD and NASA is higher, equalling 75 percent of costs incurred in 1973.[18]

These overall figures mask considerable variability between companies. The degree to which a company spends over its ceiling will depend on its financial condition, its perception of its technological opportunities, and the toughness of its negotiators. The Navy and the Air Force are said to insist on setting ceilings somewhere below actual program size. This amounts to de facto cost sharing, but the sharing ratio will vary according to the bargain struck during negotiation. The ratio of cost recovery to total costs will also vary between companies, depending on their sales mix. Some of the major IR&D companies, for example Grumman Corporation or Northrop, are heavily committed to defense production and may recover from DOD and NASA 80 to 90 percent of their negotiated ceilings for IR&D/B&P. Broadly diversified companies such as General Electric or Westinghouse would be expected to have a lower rate of cost recovery. However, most such companies are structured so that their government business is concentrated into one or more operating divisions. Each division with $250,000 or more in IR&D/B&P payments from the Defense Department qualifies for a separate advance

agreement, with the division's IR&D costs allocated across division sales only. Thus, by concentrating its DOD business and IR&D program into the same divisions, a company can maximize its recovery rate for IR&D costs.

Ceilings on B&P expenditures are also set by negotiation, but there is no requirement for technical evaluation, and military relevance is determined by the negotiator, not by the technical review process. Again, company practices vary greatly. Some companies restrict their use of the B&P cost category to only the costs of writing up a proposal. Other companies place the development work needed to meet government specifications in B&P, but consider the proposal preparation as selling expense, and put it in their general and administrative cost pool. Still others will have a mixture of engineering and non-engineering costs in B&P. So long as a company maintains a consistent system of classification, its B&P costs will be allowable, although the ceilings negotiated for B&P presumably take into consideration the accounting practices followed by the individual companies.

4. Performance of IR&D

The procedures for technical evaluation and negotiation of ceilings take several months; meanwhile the company is carrying out the IR&D projects listed in its technical plan and also beginning to plan for the next year. The company is not bound to perform the proposed projects listed in its plan, and if a new opportunity appears funds allocated to one project may be freely shifted to the new project. If the

firm wins a large contract during the year, it may reduce the size of its IR&D program by shifting engineers to the new contract work; conversely, if it loses a contract it may devote more resources than expected to IR&D. DOD regulations allow a contractor to recover costs over his negotiated ceiling for IR&D so long as the ceiling for B&P is reduced by the same amount (and vice versa), so that the two programs are interchangeable to some degree. This provision is said to give the contractors additional flexibility to respond to unanticipated opportunities; presumably it also reduces the temptation to misclassify costs between the two categories. In practice an average of 80 to 90 percent of the planned projects are carried out;[19] a company with an unusually large number of uncompleted projects would probably receive a lower score in its technical evaluation the following year.

5. Companies without Advance Agreements

In 1974 the DOD negotiated advance agreements for IR&D with 183 divisions of approximately 55 companies. Many other companies with DOD contracts recovered a portion of their IR&D/B&P costs from the government, although the amounts received were less than $2 million so that advance agreements were not required. For these companies, the allowability of their IR&D costs is determined in one of two ways, depending on their contract mix. A company with most of its business (65 percent or more) in competitive firm-fixed price contracts with DOD or commercial sales will have its IR&D costs

accepted without question. For a company below this threshold, the allowable size of its IR&D/B&P program is set by a formula utilizing data on the size of program and its ratio to total sales in the past. The DOD then pays its share of the allowable IR&D costs just as in the case of a company with an advance agreement. The DOD does not, however, undertake technical evaluation or determination of military relevance for these smaller companies, and, with only a few exceptions, data from these companies' programs are not included in the annual reports to Congress on IR&D/B&P.

Differences Between Services in the Management of IR&D

There are substantial differences in style in the methods used by the three military services to manage the IR&D programs under their jurisdiction. The Air Force and the Navy are responsible for the largest number of advance agreements. The Army has limited its participation, both because the companies for which it is the most important customer tend not to be in high technology areas and because, as a matter of principle, the Army has preferred decentralized contract administration. Therefore, it has passed on to the Defense Contract Administration Service (DCAS) the task of negotiating advance agreements for IR&D in a number of companies for which it would otherwise be responsible.

The Air Force is responsible for approximately 115 of the 183 contractor divisions which had advance agreements in 1974. It has developed a fairly elaborate management system for its IR&D program, with an Air Force IR&D Policy Council

and an internal management group which directs and oversees the company negotiations. There are Air Force regulations covering the conduct of technical evaluations, including a rating of the evaluators themselves, and an elaborate package of materials is used to communicate the results of the evaluation to the companies. In 1972, the Air Force began to link changes in a company's score from the technical evaluation to the company's negotiated ceiling for IR&D. Although the historical size of a company's program still carries the greatest weight in negotiations, upward or downward movements in its technical rating now yield an automatic adjustment in its allowable ceiling up to a maximum of +/- 20 percent. The Air Force argues that this system of rewards and penalties serves as an incentive to the technical evaluators as well as to the companies by enhancing the importance of the technical evaluation procedure.

The Navy has a less formal apparatus for making technical evaluations and using the results in the negotiation process. Technical evaluations are the responsibility of the Office of Naval Research and its branch offices. The evaluations follow the same format as in the Air Force, but there is no fixed relationship by which the company's score affects the negotiation result. In general the flexibility of an individual approach to each company is preferred to the use of a standard formula, and the Navy negotiator appears to have a large degree of autonomy in reaching advance agreements.

Several reasons can be adduced to explain these differences. The Air Force, as the youngest of the services, does not have the tradition of arsenals and strong in-house laboratories which characterize the Army and Navy, and therefore it tends to be more dependent on its contractors. Its major contractors are concentrated in the high-technology areas of aircraft and electronics, where IR&D has been an important program. The Air Force believes that its formal procedures assure impartiality in setting ceilings on IR&D programs, and are a protection against court challenges by its contractors. Finally, it can be said that the Air Force prefers formal, analytical approaches to problem-solving. The Navy's approach, on the other hand, appears to have evolved from a series of ad hoc adjustments of long-standing arrangements with its contractors in response to the new requirements imposed by DOD over the years.

Controls over Total Size of the IR&D Program

The total size of the DOD's IR&D program is the sum of the allowable and allocable costs from all of its contractors, and thus is the result of many separate decisions. Guidance for these decisions is supplied by the IR&D Policy Council, meeting in the Pentagon. The Council proceeds from a general feeling of how tight or loose money is for the Defense Department, and a sense of the proportions it wishes to maintain between IR&D, contract R&D, and spending by in-house laboratories. The most important determinant seems to be the

total size of the program the year before, just as it is for the individual agreements.

The DOD is understandably cautious in the use of words like "fund" and "allocation" to describe the annual costs of IR&D. Such language suggests the possibility of a line item in the budget, something the Defense Department has repeatedly argued against as impracticable. Nevertheless, when there have been squeezes on IR&D, notably for 1970 and 1971, the system has responded with remarkable accuracy. In 1969 legislation included a limit of "93 percent of what would otherwise have been spent" for FY 1970: DOD's 1970 spending for IR&D/B&P dropped to 93.6 percent of the 1969 figure, falling slightly more than the sales base (see Table 1). Similarly, the original language of Sec. 203 in the 1970 legislation on Defense Department Authorizations for FY 1971 called for a ceiling of $625 million for IR&D/B&P payments. Although this provision was dropped in conference on the bill, the figure for 1971 was estimated in 1972 to be $623 million (later revised to $619 million). These two instances in which the DOD actually cut back on the volume of IR&D/B&P spending show that, despite the diffuse process for allocating IR&D funds, the requirement for negotiated ceilings provides control over the total size of the program.

IV. IR&D AND THE DEFENSE INDUSTRY

Characteristics of the Defense Market

The special features of military procurement are well known.[20] Unlike other industries, the defense industry is

not defined by a given output or product line, but rather as the collection of firms which do a substantial percentage of their business with the Defense Department. Except for the large foreign military sales, which normally are under the supervision of the U.S. government, the industry's single customer for its military products is the U.S. government. The weapons procured frequently involve considerable advances in technology; they tend to be highly specialized; and, increasingly, they are procured in only small numbers. Consequently, defense procurement is characterized by relatively high rates of risk and by rapid product obsolescence. It is also characterized by close relations between the major contractors and the procurement offices and by extensive regulation. In the absence of a competitive market environment, the government has sought to supply controls on costs and profits through the rules laid down in ASPR, which now number thousands of pages and cover almost every conceivable aspect of the procurement process.

The rapid rate of technical change in defense procurement and the highly specialized nature of individual procurement items have created a situation in which price competition is relatively unimportant. Instead technical capability and managerial competence are considered more important in source selection, and it is in these areas that rivalry between firms occurs. A well-known guide to defense contracting states:

> . . . a negotiated procurement is not always awarded on the basis of price alone. Many times a proposal which is technically superior will be favorably evaluated and merit the contract, even though it will cost the Government more money. In fact, it may be observed without fear of contradiction that technical evaluation of modern sophisticated weapon or space system proposals is of more importance than price.[21]

Role of IR&D in the Procurement Process

In this general picture of military procurement, several features are particularly relevant to IR&D. The government has assumed a substantial proportion of the risks associated with high technology through its direct contract funding of most military R&D and the use of cost-plus contracts and contract renegotiation procedures to cover unexpected technical difficulties. The DOD's IR&D program is an additional method by which the risks of the defense business are largely shifted from the private contractor to the government. The dollar contribution from the government dilutes the risk incurred by defense contractors in their IR&D programs by automatically covering a large fraction of the costs incurred. The risk for the firm lies instead in the danger that it may not choose its IR&D projects wisely, and that the projects may thus fail, either for technical reasons or because they are not of interest to the firm's major customer.

These risks are not unimportant. In order to bid on large defense contracts, a contractor must maintain an expensive specialized work force and facilities. A large

volume of sales is very important in covering the cost of these resources, and, in recent years, cuts in spending for military procurement and a high rate of inflation have intensified pressures on defense contractors. IR&D projects are useful in these circumstances, both to chase potential contract dollars and to provide employment for company engineers who might otherwise have to be laid off.

In this second role, IR&D funds serve as an organizational cushion, a source of "slack" in the language of organization theory.[22] This stabilizing function meets a legitimate need for continuity in R&D, where "keeping the team together" may be crucial to assure future contributions. Nevertheless, it is susceptible to abuse, and may lead to a misallocation of resources if a firm uses its IR&D funds in areas which are not promising technologically. Mistaken judgments can occur in any field, but nondefense firms, unable to recover the costs of their mistakes, have a greater incentive for avoiding them.

The IR&D program plays an important role in the close relations between the defense industry and the DOD. The defense company's need to win new contracts provides a powerful incentive for it to shape its IR&D program to match its perception of DOD present and future interests. Coupled with the desire of DOD program officers to encourage work in their own technical areas, the result is a pattern of considerable "guidance" of individual IR&D programs by the Pentagon. As one R&D manager commented, "Every program

manager has his pet projects, and it is easy to discover them." Although direct information about other firms' programs is kept confidential, a firm may be given "negative guidance" as part of the debriefing which follows its technical evaluation; that is, it may be warned that some of its proposed projects duplicate work being done by other firms: "That field has been plowed already." Direct solicitation of IR&D effort in particular areas has also occurred on occasion. An example is the development of the engine for the C-5A, which over a period of years was developed through a combination of "directed" IR&D programs and contract R&D carried on by several defense contractors.[23] The prevalence of DOD influence on the individual company's choice of IR&D projects is an important qualification to the word "independent" in IR&D.

On the whole, the industry has been successful in its use of IR&D to win new business. A 1972 Defense Department survey of thirty major contractors indicated that on the average 40 to 50 percent of their IR&D projects resulted in DOD contracts.[24] By comparison, in another study of non-defense companies the companies sampled expected only about half this success rate. Specifically, they expected that about half of their in-house research projects would have a 50 percent or more probability of being technically successful, that is, of attaining the technical objectives within the budgeted time and cost.[25]

An important consequence of the use of IR&D projects

as a lead-in to contract business is that the companies tend to choose short-run development projects with a high probability of success over longer-run research projects. Some estimates of the development component of the IR&D program run as high as 90 percent, while a survey of a sample of Air Force contractors found that 65 percent of their programs would be classified as either development projects or systems studies.[26] Further evidence of the short-run character of most IR&D projects can be found by analyzing the information provided on forty-two projects listed by the defense industry as examples of the technological benefits of the IR&D program.[27] Thirty-six of the projects resulted in DOD contracts within two years of project inception; twenty-one led to contracts within one year. Three projects acquired contract support after three years, and only the remaining three projects were pursued for so long as five years before contract support materialized.

Other Benefits of IR&D to the Industry

Besides the need for new contracts, the defense firms face other economic pressures, which the IR&D program may alleviate. Defense companies complain that the government insists on low profit rates in negotiating defense contracts, and these complaints are borne out by a number of studies. For example, a GAO study found that for 61 defense contractors, profits were only 4.1 percent on sales to DOD compared to 8.3 percent for their commercial sales, a comparison which is,

however, controversial.[28] When one considers that in a non-defense firm funds for in-house R&D must come out of profits, it is clear that the Defense Department's payments for IR&D/B&P are an implicit supplement to the profits of the defense firms, running about 3 to 4 percent of sales. Furthermore, under incentive type contracts a defense firm maximizes its profits by avoiding cost overruns. It would be naive not to think that IR&D funds are occasionally used to rescue contract work in trouble, thus saving the contractor from overrun penalties.[29]

IR&D funds offer defense contractors the means to diversify outside the defense industry, so long as the requirement for potential military relevance is met. Congress included the PMR requirement in the 1970 law to prevent defense contractors from using DOD funds for IR&D projects totally unrelated to national security needs. The requirement, however, is only that IR&D projects must have potential military relevance. For example, Pratt & Whitney Division of United Aircraft Corporation (now United Technologies Corporation) was able to charge to its DOD contracts as IR&D $87 million in development costs for the JT9D engine used in the Boeing 747 and McDonnell Douglas DC 10 aircraft. By the end of 1973 Pratt & Whitney had delivered 1301 JT9D engines to its commercial customers and 3 to the Department of Defense.[30] The Pratt & Whitney case demonstrates the kind of advantage a defense contractor can gain in commercial markets from IR&D in spite of the PMR requirement.

A broad interpretation of PMR would seem to cover almost everything, and, in practice, the requirement has had virtually no effect on the costs recovered in IR&D programs.[31] Nevertheless, the industry and the Defense Department would like to see the PMR requirement eliminated, or at least broadened to require only government-wide relevance. They claim that the lack of observed impact for the requirement is a result of the firms' screening projects at an early stage before submission of their technical plans to DOD for evaluation. They argue further that the agency-relevant requirement erodes the independence of the contractor's programs and tends to distort the composition of the programs towards short-term projects, where relevance is easy to demonstrate. Removing the requirement however, would run counter to a general principle of public accountability, that money appropriated to the Department of Defense ought to be spent on DOD functions.

Another way in which the defense firm may benefit from the IR&D program lies in the favorable patent position under the current rules for IR&D. The firm has full proprietary rights for patents resulting from IR&D projects, whereas, for patents resulting from contract R&D for DOD, the government retains the right to a royalty-free license for its own use and can also require the firm to grant licenses to other firms ("march-in rights"). The lack of government rights to patents from IR&D has been criticized as a giveaway to the industry, since the government con-

tributes heavily financially to the work leading to the patents. However, the value in general of patents on defense R&D is questionable, since, if the government does not want the patented item, there is likely to be no other customer for it. It appears that even under IR&D-originated patents the government is almost always granted a royalty-free license.[32] Nevertheless, some patentable ideas arising from defense R&D may have broad military and commercial applications, and in these cases the defense firm is definitely better off under the rules governing IR&D than under those for contract R&D.

In summary, it is easy to see why the defense industry favors the IR&D program. In the atmosphere of rapid technological change which characterizes the defense industry, new technological approaches are the key to new business. Since fixed-price contracts increase the difficulty of passing on cost overruns to the government, there is a premium on reducing technological uncertainty before bidding. IR&D money can be used to carry a project through the early development stages before entering into a contract with the DOD. With automatic cost recovery, the financial risk to the company is reduced; the industry is, in effect, able to pursue new business largely at the expense of the government. In addition, the IR&D program is a source of organizational slack, cushioning the ups and downs of the defense market and providing a welcome supplement to the low profit rates allowed on defense contracts.

Impact of IR&D on the Structure of the Defense Industry

The continued flow of funds for the IR&D programs, for over twenty-five years now, is bound to have influenced the structure of the defense industry. The DOD estimates that it does business with over 20,000 firms, but most of the contract dollars go to a relatively small group of major contractors. The top 100 prime contractors regularly account for about 70 percent of the total value of DOD prime contracts; the top 50 companies receive 60 percent, and the top 25 about 50 percent. For the R&D component of the defense spending, the concentration ratio is even higher. In FY 1973, the top 50 R&D contractors received 86 percent of all R&D contracts; the top 25 received 75 percent.[33] IR&D payments are also heavily concentrated. In 1973 the approximately fifty-five contractors with advance agreements for IR&D/B&P received about 97 percent of DOD's total reported reimbursements for IR&D/B&P to major contractors (or about 80 percent of total payments).[34]

There is substantial similarity in the lists of top prime contractors, top R&D contractors and top IR&D contractors.[35] Table 4 lists the top twenty prime contractors for FY 1973 along with their rankings as recipients of RDT&E contracts and IR&D/B&P funds. Fourteen companies are among the top twenty in all three categories. This is not surprising, given that IR&D programs are presumably concentrated in the research-intensive sections of the defense market, and that IR&D cost recovery depends on having DOD contracts

in the first place. Various technical reasons probably account for most of the discrepancies between the lists. For example, IR&D payments on subcontracts as well as on prime contracts are counted in compiling the IR&D list, so a firm with important subcontracts would rank higher on that list than on the other two lists.

The twenty companies in Table 4 received 45 percent by value of the total prime contracts in FY 1973 and 66 percent of the total RDT&E contracts. We estimate therefore that they received approximately 55 to 60 percent of the total IR&D/B&P payments. Similar reasoning suggests that the first twelve companies alone received about 50 percent or $400 million of the IR&D/B&P payments in 1973 to major contractors.

Membership in the group of firms which dominates the defense market has been fairly stable over the past twenty years. William Baldwin, in his study of the defense industry over the period 1957 to 1964, found that for the top fifty firms on the list of 100 prime contractors, there was a net turnover of only eighteen firms for the seven year period, and of these only four were new entrants to the top 100 list.[36] If Baldwin's method of analysis is applied to the fiscal years 1967-1973, we find that there were fourteen new names in the top fifty list in 1973: one was a temporary consortium of construction companies; three were the result of mergers with companies in the top fifty; six more were among the top 100 in FY 1967; and only four firms were completely

new entries to the top 100 list.

This stability over time in the membership of the list of top fifty prime contractors and the substantial agreement between the lists of top companies for prime contracts, R&D contracts, and IR&D payments are related phenomena. Much of the new business in the defense industry is the result of continuing changes, large and small, in the available technology. The contractors' IR&D programs have contributed to the institutionlization of technological change in weapons technology, while minimizing economic instability. Large defense companies have large IR&D programs supported by their existing contracts, and their IR&D programs in turn lead to more contracts, both in R&D and in procurement. Thus, a company which has succeeded in establishing itself as a major defense contractor is helped by the IR&D program to retain its position in the market.

V. EVALUATION OF THE IR&D PROGRAM

Benefits of the IR&D Program

There is substantial agreement between the Defense Department and the defense industry about the desirability of the IR&D program. Each of the major goals formally enunciated by the DOD for the program is echoed in the industry, restated only slightly to reflect the industry's point of view. The Defense Department is concerned to build the technology base of the industry, to nurture the expertise which makes possible future developments in weaponry and to

encourage the exploration of alternative ideas; the industry agrees with these objectives and emphasizes the argument that innovative and productive R&D flourishes best in an environment free of the red tape associated with contract administration. The DOD hopes to encourage firms to be active in the defense area in order to increase the number of potential competitors bidding on defense contracts; the industry is motivated to maintain an up-to-date capability in order to win new contracts. The symbiotic relationship between the agency and industry is most evident in their support of IR&D on the grounds that it increases the economic stability of the industry. The Defense Department argues that it needs an economically healthy industry to ensure that contractors are available to bid when future need arises, while the industry seeks a cushion against shifts in procurement spending.

Pentagon and industry representatives interviewed in the course of this study argue that the IR&D program successfully meets the goals held for it and should be left unchallenged. They express the view that the problems which had afflicted the IR&D program during its rapid growth in the 1960's are now mostly solved, and that continued Congressional questioning of the program reflects only a misunderstanding about its aims and accomplishments. But when a billion dollars a year is spent by the government on a program which does not appear in the federal budget, then more is at stake than the sense of mutual benefit which the program engenders

in the military-industrial complex.

Is the Program Necessary?

At the most basic level we may question if the IR&D program is needed at all. The program has, broadly speaking, two principal aims--to increase the resources devoted by private companies to research and development in defense-related technologies, and to foster competition in the defense market. Recently the Defense Department has come to emphasize the second goal more strongly than the first. When John Foster was Director of Defense Research and Engineering, he stressed the notion that IR&D allowed the Defense Department to "capitalize on American technological innovation by the thousands of technical brains in industry throughout the country."[37] Malcolm Currie, the current DDRE, however, while still praising the contribution of the IR&D program to the technology base, has reserved his eloquence for:

> the competitive forces in our free enterprise system (which) have been fundamental to our productivity and standard of living, to our ability to compete successfully in the world market-place, and to the attainment of a defense capability which must be based increasingly on technological quality and efficient production rather than sheer brute-force quantity at any cost.

And further:

> It [IR&D] is, in fact, absolutely fundamental to a competitive industrial capability which is the high-payoff cornerstone of our economic system.[38]

This shift in emphasis has important implications for policy, since a program designed primarily to increase com-

petition will be judged by different standards than one intended to increase the technology base. However, our analysis of the program suggests that, although IR&D does allow defense firms to maintain a high level of in-house R&D activity and thus contributes to the technological rivalry between defense firms, it cannot contribute to competition in a larger sense. The design of the program insures that the bulk of the funds are paid to the large well-established defense contractors; our estimates indicate that half of the total IR&D/B&P payments go to only twelve companies. Since IR&D payments are tied to existing defense contracts, smaller companies receive smaller amounts, and nondefense companies are simply not eligible. Thus, while the IR&D program undoubtedly sustains current participants in the defense market, it discourages entry by new firms into that market. We must conclude that if fostering competition is the primary goal of the IR&D program, then the program is an extraordinarily expensive and wasteful way to reach that goal. Indeed it is doubtful whether any such program can effectively simulate competition in a market dominated by a single customer and extensively regulated by that customer.

Is the IR&D program needed to stimulate R&D in defense technology? There is a general argument that private industry will tend to underinvest in basic research from the point of view of society as a whole because only a small number of research projects ever have an identifiable payoff that can be captured by the company doing the research.

Government funding is advocated to bring the quantity of resources committed to long-range research closer to a socially optimum level.

The case for funding IR&D, however, must be examined in the light of the actual structural conditions prevailing in the defense industry. Very large sums of money, roughly $6 billion per year, are spent on contract R&D by the Defense Department in industry precisely because it recognizes that there are insufficient incentives for companies to carry out technologically advanced and expensive military R&D projects at their own risk. The general arguments for government support of R&D activities do not supply a rule for choosing an optimum level for such spending; this remains a choice to be made politically. Existing mechanisms for making these budget decisions are in many ways unsatisfactory, but in the case of IR&D they do not even come into play. For all practical purposes the Congress has not considered the IR&D program in relation to the annual RDT&E budget, and it does not set the overall level of spending for IR&D.

The defense industry has long argued that IR&D programs are a normal and necessary part of doing business and that IR&D costs are properly included in the price of its product. The industry is on weak ground, however, when it claims that IR&D costs should be recovered from the government as from any other customer. This would make sense if the government were one of many customers for a standard product sold by many producers: if, in fact, there were price competition in

the defense market. But in those areas of defense procurement which involve advanced technology, the government is usually the single customer, with a choice of very few, often only one, potential suppliers. The size of the IR&D program in a defense company is not set by impersonal market forces, but is directly related to the size of program which the government is prepared to pay for, and is set through negotiation. If there were no negotiated ceilings the companies would have every incentive to expand their IR&D programs in an escalating pattern, constrained only by the availability of scientific resources and the burden of that part of the cost borne by the company itself. This escalation would be a natural result of the extent to which technological, as opposed to price, competition does exist in the defense market. The technological rivalry, in turn, however, is based on the special demand characteristics of the single government customer; in such a situation it is misleading to invoke the name of normal business practices!

Furthermore, the theoretical arguments for government support of R&D are strongest for basic research, and become progressively less significant as one moves through the spectrum to applied research and exploratory development where technological risks are smaller and proprietary rights to the results are more easily safeguarded. The evidence suggests that most IR&D projects fall in the area of development of new products rather than basic or applied research, and certainly most technical work in the B&P category must

belong to the product development area. Considering that IR&D projects become profitable to the defense firm when they are converted to R&D contracts, while a nongovernment R&D project must undergo privately financed commercial development before it can begin to make money for the firm, one could argue that government support of IR&D is not needed to supply adequate incentives for military-related R&D. One can go further. Industry will always push its IR&D towards product development. If DOD wants to encourage long-range research, it needs a different mechanism.[39]

Despite these reservations, however, an argument can be made for the IR&D program on the grounds that it encourages an innovative atmosphere which is lacking in contract R&D:

> At any given time, a company is in the best position to evaluate its own best ideas and prospects. When research projects are judged not fruitful in terms of technical success or practical application, they can be promptly abandoned and a new approach or entirely new project quickly substituted. It is this freedom to continue pursuit of promising concepts or results, and to terminate technical efforts not achieving their objectives that is vital to the continued success of any contractor, and to his ability to compete successfully for new business.[40]

The claim that IR&D programs are valuable because of their greater flexibility is persuasive; one has only to read through the formal requirements for letting a defense contract to realize how cumbersome the procedures for initiating or changing a contract are.[41] As with any program, however,

the expected benefits should be compared to the costs before a judgment is made. Even if one is persuaded of the need for military-related R&D in addition to the programs included in the RDT&E budget, and is additionally persuaded that the IR&D program does pull resources in the desired direction, the actual working of the program must be evaluated to see if it is meeting its goals.

Is the Program Well Managed?

The problem with the IR&D program is that the facts are not available to make an independent assessment of its value. The IR&D program has grown to its present size and complexity with scarcely any participation by Congress in forming government policy for the program. Considering the substantial sums of public money involved, Congress has been notably lax in its oversight function. It has not required DOD to report either details on the program's operation or program results. The Defense Department has acquiesced in the industry's desire for secrecy and the Annual Reports on IR&D/B&P contain only aggregated data on the size of the program. The lack of detailed information minimizes the possibility of complaints from the contractors about unfair treatment, and it reduces the chance that a competitor might learn something important about a company's program, but it makes it impossible to analyze the overall costs and benefits of the program. Individual companies can and do list some impressive accomplishments which they credit to their IR&D

programs,[42] but, in the absence of information on the cost of producing these technological advances no conclusions can be drawn.

The DOD believes that its present regulations, covering technical evaluation, military relevance, and the negotiation of advance agreements, offer sufficient controls on the IR&D program. The question is, of course, how effective are these controls in practice? The DOD itself may not be to tell. Malcolm Currie, DDRE, has estimated that abuses in the form of unwisely managed projects run only one to two percent of the total IR&D program,[43] but this figure is so low as to be scarcely credible. Even though IR&D's role in gaining new business is a powerful motive for good management of the program, the companies are under other pressures as well. IR&D is a convenient accounting category for absorbing a variety of problems, from cost overruns to redundant personnel. Realistically, we must expect that in the broad spectrum of companies receiving IR&D payments, there are contractors using the program for these purposes who are not detected.

DOD's management procedures for IR&D exhibit some weaknesses. The military services have had difficulty in matching proposed company projects for IR&D with in-house scientists technically equipped to evaluate them and in insuring that the evaluation process is given a high priority by the service laboratories.[44] The evaluations may reward elaborate write-ups rather than good technical effort.

Triennial on-site inspections are supposed to serve as a check on this possibility, but the on-site review process has inadequacies of its own, and may equally misrepresent the quality of a company's program.

The technical evaluation procedure for IR&D proposals, when working as intended, is not very different from the peer review system which is the basic device for screening research projects for agencies such as the National Science Foundation. The fundamental problem with the IR&D procedures is that the results of the evaluation are only weakly linked to the negotiation for an advanced agreement. Furthermore, there is no evaluation of completed projects on a regular basis, so that comparison of the cost-effectiveness of the IR&D program to other DOD programs for support of R&D is not possible.

The negotiation of advance agreements with its major contractors has allowed the DOD to control the total volume of its payments for IR&D. However, because of variations in accounting practices, product lines, and the proportion of defense sales to total sales, the size and rate of cost recovery on IR&D programs are not directly comparable between companies. The negotiation mechanism is supposed to allow for these variations, but the very flexibility of the procedure ensures that there is no obvious way to measure the effectiveness and fairness of the controls. On the DOD side, despite instructions calling for consistent treatment of all contractors, substantial differences continue between

the services in their approach to the IR&D negotiations. Whether or not these differences result in a systematic bias in the size of negotiated agreements is impossible to tell from the information which is publicly available.

What Should Be Done?

It is clear that the present IR&D program suffers from serious deficiencies in meeting the objectives held for it by DOD. Following the Congressional hearings held in September 1975, the Congress and Defense Department should move to correct these deficiencies. A prerequisite to reform should be a clear statement by Congress of the objectives for the IR&D program. Such a statement would help to resolve the controversy surrounding program accountability, relevancy requirements and the appropriate level of support, by placing the IR&D program in the context of national priorities.

At least two possible courses of action are open for reforming the IR&D program. The existing procedures could be retained, but modified to increase accountability to Congress and the public and to improve DOD's management of the program. Alternatively, the IR&D program could be replaced by a different set of mechanisms designed to supply program accountability while avoiding the bias towards short-run development projects and the favored position of the largest defense contractors which is inevitable under the present procedures.

Even if the program is left in place, there is a

fundamental need for more public information before Congress can fulfill its responsibility for effective oversight. Ideally, one would like a clear identification of the benefits of the IR&D program to measure against the approximately one billion dollars expended on it. Practically, however, it is not feasible to quantify all the benefits from IR&D projects because of external effects, the long time lags associated with R&D programs, and the proprietary elements in the projects. However, DOD can and should make public the names of the companies involved, the amounts received, and the general nature of the work performed. The industry may oppose the disclosure of this information, but it is difficult to see how such disclosure would violate company rights. The information would at least make it possible to compare IR&D to other R&D programs and to gauge the economic impact of the IR&D program on the structure of the defense industry.

Congress should consider the costs of the IR&D program in relation to the total RDT&E budget and to the balance between resources allocated to service laboratories, to contract R&D in industry, and to IR&D. The IR&D program should enter explicitly into discussions of funding for the technology base, something which, in the past, has not happened.[45] To this end more information on the distribution of IR&D projects along the spectrum stretching from basic research to development and bid and proposal would be useful. This information is available to the Defense Department for

individual projects as part of the technical evaluation procedures, but it has not been collected and summarized for the program as a whole. The DOD should also undertake a review of completed IR&D projects on a regular basis to facilitate comparison of the results from IR&D with those from contract R&D.

Coupled with more informed Congressional oversight, the internal management of the IR&D program by DOD should be modified to increase program accountability. Given the obstacles raised by the question of proprietary rights and the general difficulties in measuring benefits from IR&D, it is probably not possible to require a detailed public accounting for the IR&D program. It is all the more necessary, therefore, that DOD controls should assure that the public funds expended for IR&D are directed to the goals set for the program. Accountability would be greatly improved by moving the technical evaluation process to a more central position in the negotiation of advance agreements, linking the company's technical score firmly to its negotiated ceiling.

The modifications proposed above would offer substantial improvements to the current IR&D program. But the Congress should also consider more radical alternatives to the IR&D program. One possibility would be to reduce the size of the program drastically, by shifting the "guided" IR&D projects to contract status, possibly under the aegis of the Advanced Research Projects Agency of the Department of Defense.

Support for more speculative, less well-defined projects could be continued under a much reduced IR&D program or by "level of effort" contracts in which only the general area of technology and the resources to be committed would be specified. This type of contract already exists; its use could be expanded to provide contractors with the funds and incentives to continue basic and applied research in weapons technology.

Another possibility which should be considered is the use of a higher profit rate on defense contracts in lieu of payments for IR&D. This method would minimize the administrative controls necessary and maximize each contractor's freedom of choice with respect to allocation of his firm's resources. Contractors are skeptical of this proposal on the grounds that the promised profit gains would be chipped away by the government in contract negotiations. However, this need not happen. Such a policy change could be more effective than any government-regulated program in stimulating additional competition in the defense market, by making it more attractive for firms to bid on defense contracts.

VI. Conclusion

A genuine dilemma exists for the present IR&D program between the goals of promoting an innovative environment for defense-related R&D and insuring that public funds are spent wisely, with adequate procedures for public accountability. The present system for IR&D is defended by its supporters on

the grounds that it is the best compromise which can be had. A careful examination of the program however, leaves many questions unanswered. There are too many areas in which the claims for the program cannot be substantiated, and too many issues raised which had not even been considered by Congress prior to the recent hearings. Congress should consider the size of the program in relation to total R&D spending by the Defense Department. It should question in detail the effectiveness of DOD's management of the program, the value of the "products" of the program in relation to its costs, and its effects on the structure of the defense market. These issues deserve a thorough airing before any decision is made on the future of the IR&D program. At the least, the program should be modified to increase public accountability and improve DOD's management. In the long run the national interest may be best served by replacing the present IR&D program with alternative methods for achieving innovative R&D in defense technology.

Footnotes

1. "Annual Report on IR&D/B&P for 1974," Congressional Record, April 28, 1975, S-5561-5568. The $200 million figure for the IR&D/B&P costs of the smaller companies was calculated using DOD's estimate that 15-20 percent of the program's total costs to DOD occur in companies outside the data collecting system. Some other government agencies, notably NASA, also have IR&D/B&P programs, but DOD's is by far the largest.

2. Dr. Malcolm Currie, DDRE, included a strong defense of the IR&D program in "The Department of Defense Program of Research, Development, Test and Evaluation, FY 1976," statement to the 94th Congress, 1st Session, 1975, pp. III 35-38. This is the first time that the IR&D program has rated more than a few paragraphs in the DDRE's annual statement; however, Dr. Currie's 1975 statement is still confined to generalities.

3. Congressional Record, July 29, 1969, p. S-26364.

4. These hearings and reports constitute practically all of the publically available literature on IR&D. The hearings are: U.S. Congress, House of Representatives, Committee on Armed Services, Armed Services Investigating Subcommittee, Hearings, Independent Research and Development, 91st Congress, Second Session, 1970; U.S. Congress, Senate, Armed Services Committee, Ad Hoc Research and Development Subcommittee, Hearings, Department of Defense Funding of Contractors' Independent Technical Efforts, 91st Congress, Second Session, 1970; U.S. Congress, Senate, Committee on Armed Services, Subcommittee on Research and Development and Joint Economic Committee, Subcommittee on Priorities and Economy in Government, Hearings, Contractors' Independent Research and Development, 94th Congress, First Session, 1975. The GAO has issued seven reports on IR&D since 1970: "Allowances for Independent Research and Development in Negotiated Contracts--Issues and Alternatives," B-164912, February 16, 1970; "Feasibility of Treating Independent Research and Development Costs as a Budget Line Item, B-164912, March 8, 1971; "Payments for Independent Research and Development and Bid and Proposal Costs--Department of Defense," B-167034, April 16, 1973; Department of Defense's Implementation of 203, Public Law 91-441 Involving Contractors' Independent Research and Development," B-164912, May 1, 1974; "Partial Report--In-Depth Investigation into Independent Research and Development and Bid and Proposal Programs," B-164912, August 16, 1974; "Independent Research and Development Allocations Should not Absorb Costs of Commercial Development Work," B-164912, December 10, 1974; and "Contractors' Independent Research and Development Program--Issues and Alternatives," PSAD-75-82, June 5, 1975. See also Report of the Commission

on Government Procurement, (Washington; GPO, 1972), Vol. 2, Part B, Chapter 4.

5. Office of the Assistant Secretary of Defense (Comptroller), "Military Prime Contract Awards and Subcontract Payments or Commitments," July 1972-June 1973, Table 17.

6. See F. T. Moore, "Incentive Contracts" in Stephen Enke, ed., Defense Management (Englewood Cliffs, N.J.: Prentice Hall, Inc., 1967), and Oliver E. Williamson, "Defense Contracts: An Analysis of Adaptive Response," Rand Memorandum RM-4363-PR, June 1965.

7. OTE included such items as long lead proposals, sales engineering, laboratory and engineering effort, etc.

8. See, for example, Dr. John Foster's testimony in the Senate Armed Services Committee 1970 Hearings, op. cit., p. 1988.

9. "Major defense contractors" are defined as those with an annual auditable volume of costs incurred on defense contracts of over $15 million, and other contractors who, although not meeting the auditable volume criterion, required 4,000 or more man-hours of direct audit effort by the Defense Contract Audit Agency. The contractors covered in the annual report include almost all contractors with advance agreements plus approximately twenty-five additional defense firms; the exact number varies from year to year.

10. The major problems arise from changes in burdening IR&D (charging overhead to the account) and redefinition of the OTE category. Burdening is now required, but the changeover in practice covered several years, resulting in a year to year increase in IR&D dollars which was not matched by an actual increase in the amount of work performed. For example $55 million of the 1972-1973 increase is attributed to the phasing-in of burdening. Similarly, much of the OTE category has been shifted to IR&D, and OTE is no longer reported separately. DOD's reported IR&D costs over the last three years have also been influenced by foreign military sales (FMS). FMS made through the Pentagon are audited by DOD and the IR&D costs are recorded as part of the contractor's ceiling, even though the foreign purchaser ultimately reimburses the United States government. The IR&D costs allocated to FMS have been: 1972, $13.8 million; 1973, $38 million; and 1974, $42 million.

11. The preliminary thinking of the Office of Federal Procurement Policy was outlined by Hugh Witt at the September 1975 Congressional hearings, op. cit.

12. RDT&E funds spent in industry were about 26 percent of DOD dollars spent in industry for RDT&E plus procurement in 1974. However, the major contractors probably have a larger proportion of their contracts in RDT&E than do all DOD contractors taken together. For example, the top twelve prime contractors in 1973 had RDT&E contracts equal to 30 percent of their total DOD prime contracts for the same year.

13. Department of Defense Instruction 5100.66, Jan. 7, 1975, Sec. IV A.

14. Cf. James Kurth, "Why We Buy the Weapons We Do," Foreign Policy, 11, Summer, 1973, pp. 33-56.

15. The material in this and the following section is based on a series of interviews with DOD and industry personnel involved in the administration of the IR&D program.

16. To offset this bias the Air Force systematically deflates the scores from on-site reviews in calculating a company's composite technical score.

17. GAO Report PSAD 75-82, op. cit., p. 34.

18. Ibid., pp. 25, 31. The category, "Costs accepted by the Government," has been taken as equivalent to the sum of the negotiated ceilings.

19. Department of Defense, ODDRE, "The Independent Research and Development Program: A Review of IR&D," (mimeo) June 1974, p. 36.

20. Good descriptions of the defense procurement process can be found in Merton J. Peck and Frederic M. Scherer, The Weapons Acquisition Process: An Economic Analysis (Boston: Harvard University, 1962) and J. Ronald Fox, Arming America: How the U.S. Buys Weapons (Boston: Harvard University, 1974).

21. Dean F. Pace, Negotiation and Management of Defense Contracts (New York: Wiley-Interscience, 1970), p. 108. Cf. also p. 129.

22. Kalman J. Cohen and Richard M. Cyert, Theory of the Firm: Resource Allocation in a Market Economy (Englewood Cliffs, N.J.: Prentice Hall, 1965), Chapter 16.

23. Interview. See also the testimony of D. G. Soergel, a private consultant with experience in the aerospace industry, at the September 1975 Congressional hearings, op. cit. He describes the use of IR&D money "to develop early hardware test data from which the government advocate could pick and choose to verify his specification without relying principally on R&D contracts."

24. Department of Defense, ODDRE, "The Independent Research and Development Program: A Review of IR&D," op. cit., p. 34.

25. Edwin Mansfield, et al., Research and Innovation in the Modern Corporation (New York: W. W. Norton, 1971), p. 20. Cf. also p. 35.

26. Air Force Systems Command, "A Background Paper on Distribution of Technical Areas of IR&D Effort," Code DLXB, Washington, D.C., February 1974. The 90 percent figure was given by D. G. Soergal in his statement at the September 1975 Congressional hearings, op. cit.

27. Tri-Association Ad Hoc Committee on IR&D and B&P, Technical Papers on Independent Research and Development and Bid and Proposal Efforts, Washington, D.C., March 1974, Chapter 3. The contractors sampled by the DOD in its 1972 survey reported a duration of two years or less for 50 percent of their IR&D projects. Department of Defense, ODDRE, "The Independent Research and Development Program: A Review of IR&D," op. cit., p. 36.

28. GAO, "Defense Industry Profit Study," B-159896, March 17, 1971. If profits are calculated as a percent of capital invested rather than of sales, the defense firms do much better; the rate of return on equity capital invested for the sixty-one defense firms in the GAO study was 22.5 percent.

29. Similarly, IR&D work may be juggled to protect the rates negotiated for other overhead categories. J. Ronald Fox, op. cit., pp. 326-27. See also Paul M. Trueger, Accounting Guide for Defense Contracts, sixth edition (Chicago: Commerce Clearing House, 1971) for several examples of controversies over the allocation of IR&D costs. See esp. pp. 440-45.

30. GAO Report, B-164912, December 10, 1974, op. cit. The controversy in the Pratt & Whitney case revolved around whether the engine development work had been contracted for by Boeing Company and was thus unallowable, not whether it met the PMR criterion, which it clearly did.

31. GAO Report B-167304, April 16, 1974, op. cit.

32. GAO Report PSAD 75-82, June 5, 1975, op. cit., p. 17. Our interviews agree with this finding.

33. 100 Companies Receiving the Largest Dollar Volume of Prime Contract Awards and 500 Contractors Receiving the Largest Dollar Volume of Military Prime Contract Awards for RDT&E, both issued annually by OASD (Comptroller). The concentration figures for R&D were calculated from data for 1973, adjusted by grouping data for subsidiaries with the parent company.

34. "Annual Report on IR&D/B&P for 1973," Congressional Record, May 28, 1974, p. S-9046.

35. A ranked list of major IR&D contractors for 1973 was supplied to us by OASD (I&L).

36. William Baldwin, The Structure of the Defense Market, 1957-1964 (Durham, N.C.: Duke University Press, 1967), pp. 16-24.

37. Statement of Dr. John Foster, Hearings, before the Committee on Armed Services, U.S. Senate, 1970, op. cit., p. 1950.

38. Statement of Dr. Malcolm Currie, to the Congressional Hearings, September 1975, op. cit.

39. The testimony of Hugh Witt, Director of the Office of Federal Procurement Policy, at the September 1975 hearings, op. cit., suggests that the OFPP's circular on IR&D, due to be issued by April 1, 1976, may include measures to restrict federal support for IR&D to basic and applied research and advanced technology by disallowing the costs of full-scale development and prototypes.

40. Tri-Association Ad Hoc Committee on IR&D and B&P, "A Position Paper on Independent Research and Development and Bid and Proposal Efforts," March 1974, p. 16.

41. For a critique of the government's current procurement procedures for R&D, see Report of the Commission on Government Procurement, op. cit., Vol. II, Part B, Chapter 5.

42. Tri-Association Ad Hoc Committee on IR&D and B&P, Technical Papers on Research and Development and Bid and Proposal Efforts, March 1974, Chapter 3.

43. U.S. Congress, Senate Committee on Armed Services, Hearings, Fiscal Year 1975 Authorization for Military Procurement, 93rd Congress, Second Session, Part 5, p. 2125.

44. GAO Report, PSAD 75-82, June 5, 1975, op. cit., pp. 38-39.

45. A beginning has been made following the September 1975 Congressional hearings on IR&D. The Senate Appropriations Committee has directed the Defense Department to submit estimates of expected IR&D/B&P spending as an information exhibit in the Research, Development, Test and Evaluation material. Aviation Week and Space Technology, Dec. 1, 1975, p. 22.

Table 1. DOD's and NASA's Payments for IR&D, B&P and OTE to Major Contractors: Dollar Amounts and as a Percentage of Sales (Millions of Dollars)

Year	IR&D	B&P	Total IR&D B&P	OTE	Grand Total	Grand Total as % of DOD or NASA Sales
			DOD			
1963	197	178	375	84	459	2.56
1964	199	182	381	71	452	2.75
1965	198	186	344	76	460	2.94
1966	224	202	426	91	517	2.89
1967	277	230	507	92	599	2.80
1968	338	271	609	64	673	3.02
1969	410	289	699	79	778	3.43
1970	376	278	654	60	714	3.35
1971	354	265	619	49	668	3.41
1972	392	306	698	37	735	3.85
1973	441	360	801	32	819	3.91
1974	457	351	808	na	-	-
			NASA			
1963	24	23	47	10	57	na
1964	50	43	93	28	121	na
1965	60	55	155	17	131	na
1966	69	68	137	17	154	3.4
1967	58	50	108	16	124	3.3
1968	61	46	107	14	121	3.7
1969	43	49	92	15	107	4.1
1970	44	48	92	9	101	4.7
1971	41	51	92	7	99	5.0
1972	40	50	90	0	90	4.5
1973	40	47	85	0	85	4.8
1974 (est)	41	41	82	0	82	4.1

na = not available

Sources:

DOD: 1963-67 Report of the Commission on Government Procurement, Vol. 2, p. 35.

1968-72 GAO, "Partial Report--In-Depth Investigation into IR&D and B&P Programs," B-164912, Aug. 16, 1974, p. 6.

1973-74 "Annual Report on IR&D/B&P, 1974," Congressional Record, April 9, 1975, S-5563.

NASA: Information supplied by NASA.

Table 2. IR&D/B&P Payments by DOD to Major Contractors and Budget Outlays for RDT&E, 1963-74 (Millions of Dollars)

Year	IR&D B&P	RDT&E	IR&D as % RDT&E
1963	375	6376	5.9
1964	381	7021	5.4
1965	344	6236	5.5
1966	426	6259	6.8
1967	507	7160	7.1
1968	609	7747	7.9
1969	699	7457	9.4
1970	654	7166	9.1
1971	619	7303	8.5
1972	698	7881	8.9
1973	801	8157	9.8
1974	808	8582	9.4

Source: Table 1, and Office of Management and Budget, Budget Review Division, "Federal Government Finances," mimeo, February 1975.

Table 3. IR&D/B&P Payments Compared to DOD Budgeted Expenditure for the Technology Base, 1974

IR&D, B&P Payments[a]	Millions of $
IR&D--major contractors	457
B&P--major contractors	351
Total	808
Estimated total IR&D/B&P payments--all contractors*	1010

Expenditures from RDT&E Budget for Research and Exploratory Development[b]	Millions of $
Spent in-house	683
Spent in industry	482
Other (Universities, FCRC's)	238
Total	1403

[a]Calendar Year 1974

[b]Fiscal Year 1974

*Total IR&D/B&P payments to all contractors estimated by taking reported payments to be 80 percent of true total.

Source: "Annual Report on IR&D/B&P, for 1974," Congressional Record, April 9, 1975, p. S 5563; and Dr. Malcolm Currie, DDR&E, "The Department of Defense Program of Research, Development, Test and Evaluation, FY 1975," statement to the 93rd Congress, 2nd Session, 1974, pp. 7-43.

Table 4. Top Twenty Prime Contractors for DOD with their Rank as R&D Contractors and Receivers of IR&D Payments, 1973

Company	Rank on Lists for: Prime Contracts[a]	RDT&E Contracts[a]	IR&D Payments[b]
Lockheed	1	2	7
General Electric	2	6	2
Boeing	3	4	3
McDonnell Douglas	4	1	8
Grumman	5	5	17
AT&T (Western Electric)	6	7	34
Textron	7	34	12
United Technologies (formerly United Aircraft)	8	11	1
General Dynamics	9	8	19
Rockwell-International	10	3	5
Raytheon	11	9	4
Hughes Aircraft	12	10	6
Westinghouse	13	15	16
Sperry Rand	14	20	20
Northrop	15	29	15
Litton	16	32	31
L T V Corporation	17	26	9
I B M	18	13	22
Honeywell	19	24	18
R C A	20	12	10

[a]Fiscal Year

[b]Calendar Year

Rankings for RDT&E contracts have been adjusted to include contracts awarded to company subsidiaries. The volume of IR&D payments contributing to the listed ranks includes payments on subcontracts as well as contracts.

Source: Department of Defense, OASD (Comptroller), "100 Companies Receiving the Largest Dollar Volume of Prime Contract Awards, FY 1973" and "500 Contractors Receiving the Largest Dollar Volume of Military Prime Contract Awards for RDT&E, FY 1973"; OASD (I&L) Major IR&D Contractors (unpublished).

Guernica (1937) by Pablo Picasso
Extended Loan from the artist to The Museum of Modern Art, New York City, N. Y